Biofortification: Consumer Surplus derived from Experimental Auctions

Ulrich B. Morawetz

***Abstract* - "Biofortified" maize varieties are being developed to combat Vitamin A deficiency in East Africa and have been found to be cost-effective relative to other interventions. This study uses experimental auctions to calculate the consumer surplus resulting from the introduction of biofortified maize. Provided the necessary assumptions on consumer rationality and constant price relations hold, we find that consumer surplus would increase substantially if biofortified maize was introduced.**

INTRODUCTION

Major staples, like rice, maize, cassava and sweet potato are being modified by the CGIAR (Consultative Group of International Agricultural Research) to contain more provitamin A, which the human body can convert to vitamin A. It is hoped that these "biofortified" varieties will reduce vitamin A deficiency in Africa, Asia and Latin America which causes night-blindness and weakens the immune system among poor lactating women and small children.

While the costs of development and dissemination are comparatively straightforward to estimate, the potential gain in consumer surplus for the targeted population is much harder to estimate. We attempt to do so for Kenya where vitamin A deficiency is widespread. In Kenya, maize meal is the major staple food. The common maize meal is white, but the biofortified variety is, due to the increased provitamin A content, yellow. Unfortunately, many Kenyans associate yellow maize with food aid and bad taste. The CGIAR is concerned how well a yellow, biofortified maize meal is perceived by Kenyan consumers. In this paper we show how the change in consumer surplus can be derived from experimental auction data. Under the condition that the rather strict assumptions hold, we calculate the consumer surplus changes from the introduction of biofortified maize in Eastern and Western Kenya.

Previous impact assessment studies about biofortifiaction in Kenya calculated the cost-effectiveness based on DALYs (Disability-Adjusted Life Years)(Meenakshi *et al.*, 2010)or limited their analysis to the estimation of the WTP(Willingness to Pay) for product characteristics(De Groote *et al.*, 2011). We aim to derive the change in consumer surplus from the introduction of biofortified maize from revealed preferences elicited in experimental auctions by De Groote et al. (2011). Lusk and Marette (2010) demonstrated that, in certain situations,consumer surplus estimates from experimental auctions are possible.

We explicitly show which assumptions are necessary to calculate consumer surplus from experimental auction data. Assuming the assumptions hold, we provide the change in consumer surplus based on WTP estimates. We thus provide the first estimate of the change in consumer surplus from biofortification based on experimental auctions.

METHODOLOGICAL FRAMEWORK

Experimental auctions are used extensively by researchers to elicit the WTP for food which has been genetically modified, organically produced, or irradiated. The popularity of experimental auctions is likely to be related to the straightforward interpretation of the result: the bids collected from the participants are interpreted as maximum WTP.

The change in consumer surplus, though, is hardly ever part of the experimental auction studies. This issue has been taken up by Lusk and Marette (2010). They define $WTP_{i,R}$ as the WTP of consumer *i* for the regular product and $WTP_{i,N}$ the WTP for the new product. Their prices are P_R and P_N, respectively. Before the introduction of the new product, the consumer surplus from one unit of the regular product for consumer *i* is

$$CS_i^{before} = max\{WTP_{i,R} - P_R\, , 0\}$$

The surplus is thus the difference between the WTP and the price if it is positive, or alternatively, if it is negative it is zero because the product is not bought.

After the introduction of the new product, the consumer can decide between the regular, the new and neither of them. The consumer surplus is thus

$$CS_i^{after} = max\{WTP_{i,R} - P_R\, , WTP_{i,N} - P_N\, , 0\}$$

The consumer is assumed to choose the product which yields the highest consumer surplus if at least one of them is positive. Otherwise none of them is consumed and the consumer surplus for these products is zero.

The change in consumer surplus for the average of the total *L* persons which each consume N_i goods is

$$\Delta CS = \frac{1}{L}\sum_{i=1}^{L} N_i\{CS_i^{after} - CS_i^{before}\}$$

The change in consumer surplus will never be negative due to the introduction of a new product since

[1] Ulrich B. Morawetz is from the University of Natural Resources and Life Sciences Vienna, Institute of Sustainable Economic Development, Vienna, Austria (Ulrich.Morawetz@boku.ac.at).

the consumer can still buy the old product if it yields a higher surplus.

The derivation of the change in consumer surplus in this way requires, along with other assumptions, that consumers are fully rational, the price relations remain unchanged, and the sample is representative over the population and time.

Data and Empirical Method

The data were collected in the years 2005/06 and 2009 in the provinces Siaya and Vihiga in Western Kenya and Machakos and Makueni in Eastern Kenya. The former provinces have been selected because there yellow maize is consumed regularly and the latter due to the high poverty rates and good accessibility. In total 651persons were surveyed. Details on the survey design can be found in De Groote *et al.*(2011).

To calculate the change in consumer surplus through the introduction of biofortified maize, we assume the WTP for biofortified maize is a combination of the WTP for plain white, fortified white and plain yellow. Then, the WTP for biofortified maize meal is the WTP for white maize meal, reduced by the discount for the color yellow and increased by the premium for fortification. Given this artificially constructed WTP for biofortified maize meal, the scenarios presented, are the consumer surplus when the price for biofortified maize meal equals the price for white maize meal, when it is 20% higher, and when it is 20% lower.

Results

The change in consumer surplus resulting from the introduction of biofortified maize meal was substantial. It was highest in Western Kenya because consumers there are used to eating yellow maize and consequently the discount for the yellow colour was lower. The scenario where the price of biofortified maize equals the price of white maize resulted in an increase of the consumer surplus by 364 KShs per year for the average consumer in Siaya and 281 KShs inVihiga. For 364 KShs, for example, it would have been possible to buy 15.5 kg of plain white maize meal. This is 15% of the average per capita yearly maize consumption in Kenya. In Eastern Kenya, where consumers usually do not eat yellow maize, the change in consumer surplus wassubstantially less (equivalent to 4.3kg for Machakos Town in 2005/06 and 2009). If the price of biofortified maize meal was 20% higher than the price for plain white maize meal, the change in consumer surplus would have been between 153 KShs (6.5 kg) in the Western Kenya and 38 Kshs (1.4 kg) in Eastern Kenya. If the price of biofortified maize meal was 20% lower than the price for plain white maize meal, the change in consumer surplus would have been between 670 KShs (28.5 kg) in Siaya in Western Kenya and 331 KShs (12.2 kg) in Machakos Town in Eastern Kenya in 2005/06.

Conclusion

We estimated the average yearly consumer surplus change per person resulting from the introduction of biofortified maize in Western and Eastern Kenya. In a scenario where the price of the biofortified maize meal equals the price of the plain white maize meal, we find an increase in consumer surplus of at least equal to 12kg per person per year for the two regions where consumers usually do eat yellow maize. For the regions where consumers usually do not eat yellow maize we find the consumer surplus to be at least 4.3kg per person per year. Since the surveys were only done at one point in time, seasonal influences are not covered.

A central assumption is that consumers are rational when bidding in the experimental auctions. This requires participants to be fully informed about Vitamin A, prices of substitutes, discounting, and bidding. We doubt that this is the case for the majority of participants. To increase rationality, we recommend "valuation workshops" with consumers prior to the participation in the experimental auctions. Further, a food market model would help consider price relation changes after the introduction of biofortified maize varieties.

References

De Groote, H., Kimenju, S. C. and Morawetz, U. B. (2011). Estimating consumer willingness to pay for food quality with experimental auctions: the case of yellow vs. fortified maize meal in Kenya. Agricultural Economics 42: 1-16.

Lusk, J. L. and Marette, S. (2010). Welfare Effects of Food Labels and Bans with Alternative Willingness to Pay Measures. Applied Economic Perspectives and Policy 32: 319-337.

Meenakshi, J. V., Johnson, N. L., Manyong, V. M., De Groote, H., Javelosa, J., Yanggen, D. R., Naher, F., Gonzalez, C., García, J., et al. (2010). How Cost-Effective is Biofortification in Combating Micronutrient Malnutrition? An Ex ante Assessment. World Development 38: 64-75.